THE NATURE CONSERVANCY NEWS

September/October 1983

MIGRATION

Bon voyage!

Frans Lanting

The hatchling does the hard part.
All we have to do is keep the beach.

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THE NATURE CONSERVANCY NEWS

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No Passport Required 4
John P. Wiley, Jr.

The Platte: A River of Birds 6
Paul A. Johnsgard

Sea Turtle Conservation in the Caribbean ... 11
Archie Carr

The Eastern Seaboard: Avian Highway 16
Roger F. Pasquier

Migratory Monarchs: An Endangered Phenomenon 20
Robert Michael Pyle

Ecology Forum: Preserve Design and Migratory Species 25
Robert Chipley

New Projects 27

Notes 30

COVER: Sandhill cranes at day's end on Nebraska's Platte River, where the Conservancy helped safeguard 2,000 acres of matchless migratory bird habitat. Photo by Paul Johnsgard.

The Nature Conservancy is a national conservation organization committed to the preservation of natural diversity by protecting lands containing the best examples of all components of our natural world.

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No Passport Required

by John P. Wiley, Jr.

LIKE COMMUTERS on a cosmic schedule, some of the animals we treasure most spend a good part of their time traveling. They migrate, moving with the seasons and their own life cycles in rhythms established long before erect hominids took notice of their arrivals and departures. Striped bass and bluefin tuna school up and down the East Coast; grey whales cruise the West Coast like so many pods of friendly submarines. Polar bears pad north through Churchill, Canada, to come south again on the ice floes. Monarch butterflies flutter all the way to Mexico, to be replaced by their progeny on the return trip. Salmon find their birthplaces at the heads of rivers, while eels leave the streams and creeks to spawn in the open ocean. Sea turtles and grunion arrive at the right beach on the right tide to lay their eggs ashore. Other sea creatures migrate between deep water and shallow, between the surface and the lower regions.

Most of all, migration means the birds that come and go faithfully every year: skeins of geese honking overhead, warblers that appear briefly in the backyard, shorebirds that feed on the local beach for a day or two before continuing on to the Arctic—or to Argentina. Temperate North America is a great avian cafeteria that opens each year. Customers flock in by the millions. Insects and fruit and seeds appear explosively, enough food to raise a new generation. By the end of summer, an estimated 20 billion birds are living in North America north of Mexico. Then, as winter marches south, the exodus begins. Fully half of the 660 bird species that breed in North America winter in the tropics.

Our lives—and our ecosystems—are infinitely richer for these itinerants. It is alarming to think of life without them; not only would we miss them, but the insects of summer would quickly overwhelm us. Leaving aside all questions of aesthetics and ethics (do they have any rights to the planet on which they have lived so long?), we need them, as simply as that.

The strategy of migration clearly works, and yet it involves special risks. Presumably birds would not migrate if they could find enough food to raise their broods in the south, or if they could survive the winters in the north. They take on the risks of migration only because these are less than the risks of staying where they are. Migrating birds immediately give up the advantages of familiar territory. Flying nonstop, sometimes for several days and nights, they can be blown off course, especially when clouds cover the sky—a disaster when it happens over open water. Over land, birds use traditional resting areas along their routes, a fact well known to hunters. Flying at night, as many small birds do to avoid predators, they risk running into power-line pylons and television-transmitter towers (10,000 birds were killed at just one tower in just two consecutive nights). They may complete the flight of several

thousand miles to Central or South America only to find their winter home has been cleared for agriculture, or arrive in North America on the first breeze of spring to discover a shopping center where they nested last year.

Yet migrate they do, sometimes over enormous distances. The Arctic tern spends eight months a year moving between the Arctic and Antarctica and back again, a distance of 25,000 miles. One population of humpback whales makes the round trip from the North Pacific to the Indian Ocean every year, swimming 10,000 miles each way. It can change our view of the world to know that the bird we see now may be in the Caribbean next week and deep into South America the week after that.

Migration occupies some of the best minds today, just as it did Aristotle's two thousand years ago. The phenomenon is visible to anyone who cares to look. It raises questions as provocative as any in all of natural history. How did such behavior evolve? Why don't migatory birds hibernate like bats, as they were once thought to do? How do these animals navigate over such long distances?

RESEARCH DIVIDES BROADLY into the questions of what the animals do and how they do it. To find out *what,* scientists still depend heavily on visual observations, augmented by narrow-beam radar, satellite tracking, and other high-tech sensory extensions. When they can, they attach radio transmitters and follow in airplanes. When they cannot, they band and color-code birds, tag whales and turtles, spray-paint butterflies, attach tiny clips to bats' wings, paint numbers on the sides of polar bears—all so they can know that the individual seen here is the same one that was marked there.

Reprinted by permission of Chronicle Features, San Francisco

"This is it, Webster . . . We're onto the secret of migration."

Finding out *how* carries biologists from observational to experimental science. Birds are kept in artificial environments and exposed to unnatural day lengths, to artificial suns in the wrong parts of the "sky," and even to out-of-season night skies on the domes of planetaria. They are released in unfamiliar areas, sometimes with their vision obscured by frosted lenses or with miniature magnets tied to their heads to blank out the Earth's natural magnetic field, so that we can discover what they really need to navigate. New questions arise as old hypotheses are put to the test. It may be possible, for example, that birds can hear extremely low-frequency sounds: it has been speculated that a bird flying down the middle of North America can hear the surf on both coasts. We are learning more every year, including how much more we have to learn.

With increasing knowledge comes increasing responsibility. Less and less can we plead ignorance. After decades of banding, we know not only where migrating birds go but often the route they take to get there. We are discovering the "staging areas" where they rest and feed on the trip (some birds double their weight before embarking on the next leg of a journey). The volunteer network known as the International Shorebird Survey compiles sightings by 300 ornithologists in 20 countries up and down the Americas. They know which mud flats in Massachusetts and which beaches in Delaware Bay are used by red knots on their annual circuit between southern Argentina and the high Arctic. They do not yet know where the birds make their landfall in northern South America—but worry that market hunters do.

Conservationists have been very successful at protecting breeding habitat. Now we are well into the next, equally critical phase: protecting the way stations these long-distance travelers must have to complete their appointed rounds. We are making new maps of the Americas, maps that show the features important to a Swainson's hawk or a ruby-throated hummingbird on their perilous journeys. We are learning again that just as the birds themselves transcend national boundaries, conservation efforts on their behalf must do the same.

John P. Wiley, Jr., a senior editor at *Smithsonian* magazine and weekend naturalist, has been watching birds come and go since childhood.

The Platte: A River of Birds

THE DARKENING SKY was awash with thousands of sandhill cranes. The sun had just disappeared below the western horizon, its red afterglow still fresh on the broad Platte River. Then, from above and behind me great hordes of the trumpeting cranes appeared overhead, cupping their wings and pitching headlong into the river only a hundred yards away. The sound of their cries—a bugling rattle that, as always, sent an involuntary shiver through me—rose and fell in crescendos and diminuendos as one flock after another passed overhead and dropped down to the river. Adding to the pandemonium were the taunting shrieks of white-fronted geese and the yelps of Canada geese, which were coursing up and down the river a thousand feet or so above the cranes as they, too, sought a safe roosting place for the night.

The place was the central Platte River Valley near Grand Island, Nebraska, and the time was mid-March, 1983. Yet, it might as well have been 1883 or even 1783, as there were few visible signs of civilization. To be sure, a few telephone lines punctuated the distant horizon, and directly behind me stretched a corn-stubble field where the cranes had fed throughout the day and had gath-

Tom Mangelsen

by Paul A. Johnsgard

ered in late afternoon before their short sunset flight to the river. But surely a century ago—and for uncounted centuries before that—the cranes had been there in mid-March, for they were responding predictably to the lengthening days of spring, assembling again at their ancestral staging areas on the Platte River. In a few weeks they would be pushing on toward nesting grounds scattered across northern Canada and coastal Alaska. In some cases, they would travel across the Bering Sea to Siberia, still 3,000 miles away and more than two months ahead in the cranes' instinctive timetable. During the approximate month they spend in the Platte Valley, the birds gain substantial weight—fat reserves for the long migration ahead—and also prepare physiologically for the upcoming breeding season.

After the cranes have all landed on their nighttime roosts along sandy bars, sparsely vegetated islands, and nearby shallow stretches of the river, they gradually become quiet. Individual birds find their mates and family members; the flock settles in for the night. Standing in the cold Platte water throughout the night, sometimes with ice crystals forming around their legs, the birds are safe from coyotes, dogs, and other terrestrial predators. There they remain until the first light awakens them, and they fly out again to feed in the adjacent meadows and fields.

Thus, from about the first week of March until early April, the lesser sandhill cranes funnel into Nebraska from wintering areas in Texas, New Mexico, and northern Mexico. They concentrate along the Platte River, and at the time of their peak numbers in late March reach a total of around 560,000. This figure represents four-fifths of the world's population, and virtually all of North America's population, of sandhill cranes. It is probably the greatest single crane gathering anywhere on Earth. The cranes share the Platte with some 250,000 white-fronted geese and thousands of small Arctic-nesting races of Canada geese, all similarly bound for breeding grounds across the tundra of northern Canada and Alaska. In addition, tens of thousands of ducks—primarily pintails, mallards, common mergansers, and other hardy species—form the vanguard of the massive spring migration through the heart of North America. All told, seven to nine million ducks and geese pass through the region.

DURING DAYLIGHT HOURS, when the cranes are foraging in nearby fields and wet meadows, the river typically is alive with ducks, most of which are actively courting. Meanwhile, the small Canada geese and greater white-fronted geese often feed in company with the cranes. These birds periodically visit the river to drink during the day; they return late in the evening to roost near the cranes. Yearly concentrations of both ducks and geese on the Platte vary far more than the crane populations. In wet springs the waterfowl tend to converge south of the Platte, in standing-water habitats of the Rainwater Basin. Because this area's clay soils drain poorly, temporary "lagoons" form during snowmelts and spring rains. The cranes generally shun the basin for roosting, perhaps because of the lagoons' unpredictability and generally small size.

In normal years, waterfowl reach their highest

numbers on the river well before the cranes, usually by mid-March. Most of the geese leave the Platte Valley by the end of that month, or just as the crane numbers culminate. Bald eagles leave with the waterfowl, which the raptors usually follow northward, as soon as habitats in the Dakotas become ice-free. The Platte River is one of the most important wintering areas in the Great Plains for the endangered eagles, whose total numbers in the central Platte Valley sometimes reach nearly 250.

Two other rare bird species migrate to the Platte and remain there to breed. One is the interior race of the least tern, a form that has become extremely rare in recent years throughout most of its range. The Platte River, especially from Mormon Island east almost to the Platte's confluence with the Missouri River, supports many small colonies of least terns. These birds nest on sandy islands that persist through the winter or emerge during late spring as river levels begin to decline. Similar sand bars and islands host several nesting pairs of piping plovers, a species also threatened or endangered over most of its central North American range. Like the terns, the piping plover is adapted to an ephemeral spring habitat of relatively barren sandbars that are subject to possible flooding should river levels rise quickly. By the same token, if water levels should drop during the nesting period, terrestrial predators would have easier access to the plovers' nests.

THE AGE OF THE PLATTE is impossible to guess. Perhaps its antecedents go back more than 50 million years, when the Rocky Mountains were rising and beginning to intercept moisture-laden winds. The rains and snows that fell on the crests of the infant peaks gathered into rivulets and streams. Surely some of these streams must have tumbled down the mountains' eastern slopes and then meandered out onto the drier plains, where they began to create a watery trail across the more gently sloping lands to the east.

During early Pleistocene times, the first of a series of continental glaciers began to have massive effects on the life and land of central North America. For nearly two million years, these glaciers molded and recast the landscape that is now encompassed within the northern plains, depositing enormous loads of glacial till in some areas and gouging out other regions to bedrock. Undoubtedly the Platte River must have been greatly affected by these resculpturings, and the areas through which it wound its way must have changed greatly over the eons. However, by the early stages of the last major glacial period, the Wisconsin, the

Tom Mangelsen

Sandhill cranes wade Nebraska's Platte River. In late March, their numbers reach 560,000: 80 percent of the world's population and virtually all of North America's.

Tom Mangelsen

Tom Mangelsen

Common mergansers (above) and Arctic-nesting Canada geese (at left) are among the many migrants that share the Platte each spring with sandhill cranes. In all, seven to nine million ducks and geese pass through the region on their journeys north.

river was probably passing through a grassland-dominated region not unlike the present-day scene.

Here, one might easily imagine that caribou and mammoths grazed on the fragrant prairie grasses, and bison wallowed in the river's muddy pools. Quite probably sandhill and whooping cranes were already very familiar with the Platte, for a fossil sandhill crane humerus found in Sioux County, Nebraska, dates back some nine million years. It is the oldest known bird fossil attributed to a currently living species—and is indistinguishable from that of a modern sandhill crane.

More recently, in the period between 4,000 and 2,500 years ago, the climate continued to warm but also became drier, causing extinction of nearly all of the plains' northern plant species. The prairie grasses spread inexorably outward to do silent battle with the intruding forests and to win in all but the moistest and shadiest river valleys. The river flowed on, always bringing new water from the Wyoming and Colorado mountains. It took virtually nothing in return, save the silt or sand it carved out of an occasional stretch of shoreline as it twisted its way across what is now Nebraska. Even this was given up as easily as it had been taken, for the river deposited materials wherever its course was slowed. In this fashion, new bends, channels, and isolated islands were continually being formed and reformed, molding and recasting the landscape over the Platte's broad and pliable floodplain. The river was to become the lifestream of the entire area. Countless herds of bison, which used to make their annual migrations up and down the plains of North America, depended on the Platte's waters. The trails they cut into the land radiated out from the river's edges like branching blood vessels.

The Platte River also became a lifeline to human populations traveling west and, later, to homesteaders who exploited the river as a source of water for irrigating the "Great American Desert" in eastern Colorado, eastern Wyoming, and western Nebraska. From the earliest and relatively modest irrigation projects of the 1870's to the re-

cent large and highly expensive diversion efforts, it is probable that about 70 percent of the Platte system's historical water flow has been detoured to agricultural uses. As a result, the river's migratory bird habitat has been progressively sacrificed to human needs.

THERE ARE THREE major threats to the Platte River habitat. First, the river's adjacent wet meadows, which migratory cranes require for feeding, are being plowed and converted into row crops, primarily corn. These grasslands provide essential proteins and calcium (contained in snails, earthworms, and other invertebrates) that corn or other grains lack. The meadows also serve as staging sites for the cranes' elaborate courtship dances.

The other two threats—insufficient water in the river channel and the encroachment of woody vegetation on banks and sandbars—are destroying the cranes' nocturnal roosting sites. These areas are characterized by shallow water (to a depth of around six inches) and open channels, free of vegetation, that are at least 180—but preferably 500—feet wide. Historically, heavy flooding and spring ice flows scoured away any plants that may have taken root on the sandbars or river banks. Periodic flooding also prevented germination of seeds from trees. But as upstream diversions reduced water flow and as dams controlled flooding, the Platte River began to change. The once wide, open, meandering channels became narrow, wooded, and stationary.

By the late 1970's most of the Platte River upstream from Kearney had been so degraded by water-flow reduction and associated vegetative incursion that the migrating cranes were being progressively forced into more marginal and more restricted roosting sites. At present, most of the migrating sandhill crane flocks are concentrated within a 50-mile stretch of the river, between Kearney and Grand Island, Nebraska, and the birds' maximum numbers are found in the vicinity of Mormon and Shoemaker Islands.

In 1978 the Department of the Interior designated portions of the 50-mile expanse as critical habitat for the federally endangered whooping crane, a species with a population of under 100 individuals in the wild. (There were five confirmed whooping crane sightings in the Platte River Valley between 1950 and 1981. By maintaining and restoring habitat, conservationists hope to draw the highly imperiled birds to the area once again.) In 1979 the National Wildlife Federation and the State of Nebraska filed suit against Basin Electric Power Cooperative under the Endangered Species Act to prevent construction of the Greyrocks Dam on Wyoming's Laramie River, a tributary to the North Platte. The suit, which alleged that the dam would damage the critical habitat area, was settled in part when Basin Electric Power Cooperative agreed to establish and fund the Platte River Whooping Crane Habitat Maintenance Trust in the amount of $7.5 million. Dedicated to preserving Platte River habitat for migratory birds, the Trust is administered by representatives of the State of Nebraska, the National Wildlife Federation, and Basin Electric Power Cooperative.

The Trust's first major undertaking, in December of 1979, was to fund The Nature Conservancy's purchase of 2,000 acres on Mormon Island. (The Trust subsequently preserved an additional 1,200 acres on nearby Shoemaker Island.) The primary purpose of acquiring land along the Platte is to prevent plowing of the wet meadows, as well as to allow access to the river channel for clearing banks and sandbars. Mormon Island Crane Meadows is owned and managed by the Trust, while the Conservancy holds a conservation easement on the property to ensure its protection in perpetuity. The Conservancy prepared the management plan now in use at Mormon Island.

To preserve and expand the sanctuary's wet meadows, management techniques include rotational grazing and prescribed burning, which promote the growth of native grasses. Woody vegetation is being mechanically removed in and around the channel to enlarge the cranes' night-roosting sites. To date, five miles of shoreline have been cleared, effectively widening the river to attract cranes and waterfowl, as well as the rare least terns and piping plovers that nest on the barren bars.

THE TRUST and the Conservancy are continuing to work together on preservation efforts along the Platte River. Despite these endeavors, other planned water-diversion projects pose a threat to instream flows required to maintain migratory habitat on the river. Should these projects be haphazardly executed, and should the wet meadows continue to be plowed, it is possible that the Platte—whose creation predates human history—may well cease in our lifetimes to be a viable river over most of its lower length. What then may happen to the cranes, whose yearly springtime clamorings have been like tickings of the geological clock?

Paul Johnsgard is Foundation Professor of Life Sciences at the University of Nebraska, as well as the author of 18 published or in-press books. Portions of this *News* article were derived from materials to be included in a forthcoming book, *The Platte: Channels in Time.*

Frans Lanting

Green turtle

Sea Turtle Conservation in the Caribbean

by Archie Carr

BACK IN THE 1950's, when concern over endangered species began to spread, the marine turtles were among the first groups of animals to receive international attention. Since then, considerable progress has been made in controlling some of the factors that threaten the group, but serious problems remain. Sea turtles are particularly difficult species to protect, owing to the complexity of their life cycles, the world demand for high-priced sea turtle products, subsistence hunting, entrapment in shrimping nets, beach development, and pollution of coral reefs and ocean waters.

Although there are important gaps in what we know about the habitat needs of all sea turtle species, it is clear that no population of any of them can be completely protected within a single refuge. There are five genera of marine turtles: the green turtles (*Chelonia*), the hawksbills (*Eretmochelys*), the ridleys (*Lepidochelys*), the loggerheads (*Caretta*), and the leatherbacks (*Dermochelys*). All these share a basic pattern of migration from one habitat to another. The young hatch on land and on leaving the nest go straight to the sea, where they swim directly away from the shore. For a year or two they are pelagic (oceanic), perhaps drifting in currents where bands of floating algae or macro-plankton are concentrated. On approaching maturity, all the species move to inshore waters and begin the adult feed-

SMITH ISLAND
SEA TURTLE PROJECT

The 11-mile-long beach at Smith Island (alias Bald Head Island) supports North Carolina's largest single nesting population of loggerhead sea turtles. From roughly the beginning of June to the end of August, the 300- to 400-pound females arrive—coming ashore at night and lumbering across the sand. Using their flippers, they scoop out flask-shaped holes into which they drop their leathery, golf-ball-sized eggs (an average clutch contains 120), cover them with sand, and return to the sea. The entire process takes around an hour.

In 1980 an estimated 78 percent of the threatened turtles' nests were lost to predation and erosion. Today—through a project backed by the North Carolina Nature Conservancy, the state's Wildlife Resources Commission, the North Carolina Natural Heritage Program, Bald Head Homeowners Association, and Bald Head Corporation—almost all the nests are being protected. Two biologists patrol the beach each night throughout the nesting season. As soon as a loggerhead has finished covering her nest, one of the biologists places a square wire-mesh screen over it. This keeps predators out but allows hatchlings to exit some 60 days later.

Nests subject to erosion at the beach's southern end are moved to a simple hatchery on the island. When burying these eggs, the biologists attempt to duplicate the shape and size of the nest dug by the mother. As the hatchlings emerge, they're helped in finding their passage to the sea.

During the 1982 nesting season, 96 nests were confirmed on Smith Island's beach. Of these, 46 were covered with wire mesh; 50 were relocated in the hatchery. Seventy percent of the eggs from all 96 nests hatched successfully. Because of increased nesting activity this past summer, more nests were being protected as of late July, 1983, than during the entire previous season.

ing regimen. For example, the herbivorous green turtle moves onto beds of marine vegetation, where it grazes by day and sleeps by night. It is still not known where adult leatherbacks, loggerheads, and ridleys migrate to feed.

Obviously, effective custodianship of such wide-ranging travelers is an imposing challenge. A population may spend part of its time at a breeding ground where it is adequately protected from poachers and predators, and then travel far away to a feeding habitat where protection is nonexistent or impossible. Loggerheads tagged on beaches of the U.S. Atlantic Coast are sometimes recovered across the Gulf Stream in the Bahamas, or in the West Indies. There is some evidence that the leatherbacks which nest on Caribbean shores migrate all the way to New England and feed on the seasonal bloom of jellyfish there.

The best known migrations are those of the green turtle, which people have exploited for centuries as a source of food. Unlike other sea turtles, it is herbivorous and tends to congregate to feed on beds of submarine vegetation, particularly turtle grass, which grows only in protected places where there is little wave action. But, like the others, it nests on exposed shores where sand beaches have been built up by heavy surf. Thus, the nesting and feeding grounds are widely separated and, as a result, some green turtles migrate a thousand miles or more to reach their breeding habitats. The population that for 26 years has been tagged and charted at Tortuguero, Costa Rica, comes to that 22-mile beach from all around the western Caribbean. Its main feeding pastures are in Nicaragua, Panama, and Colombia, but tagged individuals have been reported from as far north as Florida and the Gulf of Mexico, and as far east as Martinique and Trinidad. Tagging projects have shown that the green turtles which feed along the coast of Brazil journey all the way out to tiny Ascension Island in the central equatorial Atlantic to nest.

Although the migrations of the other species have not been well traced, they probably differ considerably. The hawksbill appears to have the least tendency to make regular migrations. It occupies coral reef habitats, feeding mainly on invertebrates, and nests on the short stretches of sandy shore that may be associated with the reef forage ground. Its feeding and nesting places are thus not necessarily as widely separated as those of other species. Nevertheless, tagging has shown that hawksbills sometimes make lengthy migrations, for reasons that remain wholly unknown.

A hindrance to making clear decisions on how to allocate efforts and resources in sea turtle conservation is the elementary state of our understanding of the group's taxonomy. We don't really know how many species and subspecies there are. The five genera are well defined; and in these, eight species are generally recognized. If these species were as well represented in museum collections as are most other vertebrate animals—and if large

series of specimens of comparable age groups could be studied by up-to-date taxonomic procedures—the number of sea turtle "kinds" bearing scientific names would be far greater. If, as we claim, it is a basic obligation of conservation to conserve genetic resources, then saving only the eight currently recognized sea turtle species is not enough. In the Atlantic and Caribbean, for example, there is just one species of the green turtle, *Chelonia mydas*. It was described from Ascension Island by Carl Linnaeus long ago. However, the species has four large nesting grounds in the Atlantic, and the population at each of these areas mates and nests virtually nowhere else. After the breeding season is over, the turtles disperse to widely separated feeding grounds; but when the next breeding season occurs, each turtle consistently returns to its home nesting shore to court, copulate, and nest again. The navigation systems by which their journeys are guided are completely unknown, but they are surely complex. Although evidence of genetic differences among these separate breeding colonies has been slow in coming, there are subtle differences in body form and behavior, and probably hidden biochemical differences exist as well. Each of the four green turtle breeding colonies of the Atlantic system is almost certainly a genetically separate entity and each must be preserved.

BUT WE FACE LOSSES more serious than the devastation of local breeding colonies. The extirpation of sea turtles from entire regions, which has been taking place for centuries, is accelerating; and some of the taxonomically recognized species clearly face extinction. Kemp's ridley, which nests only on the Gulf Coast of Mexico, is so diminished that the species may be irretrievably lost. The black turtle of the Pacific Coast of Mexico seems headed toward a similar fate. Throughout its range, the hawksbill is under intolerable pressure from the tortoiseshell trade. Inflated prices now being paid for tortoiseshell make it profitable for commercial divers to ransack the farthest reefs of the Caribbean and of all the tropical seas of the world. Today the hawksbill is clearly the most endangered species of sea turtle in the Caribbean.

Although international commerce in Caribbean sea turtle products has been controlled to some degree by the Convention on International Trade in Endangered Species (CITES), local turtle laws are generally weak and enforcement is inadequate. As the Caribbean region develops, the remaining

C. Allan Morgan

Kemp's ridley hatchlings head off on their first ocean voyage. The rarest and most vulnerable of the sea turtles, this species nests exclusively on Mexico's Gulf Coast.

Frans Lanting

Leatherback turtle

BLOWING ROCKS

Jupiter Island, off Florida's east coast, is the only known nesting site in the U.S. for as many as four species of sea turtles: loggerhead (averages 2,500 nests each year), green (15 to 20 nests per year), leatherback (3 to 5 nests annually), and hawksbill (an individual has nested repeatedly on the island). The Conservancy's Blowing Rocks Preserve, on the island's southern end, supports the densest population of nesting sea turtles in the nation.

Since 1969, members of the Atlantic Loggerhead Turtle Research project—administered by the Izaac Walton League's Loxahatchee River Chapter—have tagged more than 7,000 of the island's egg-laying turtles to determine the frequency of nesting, as well as movements between nestings. (Loggerheads appear to average two nests per turtle per season, though some may nest several times.) By analyzing reproductivity and movement, scientists can better decide how much beach a turtle requires and, in turn, how to adequately manage sea turtle nesting beaches. In addition, researchers count nests and crawls, and frequently relocate nests threatened by erosion or predators. The entire project is aimed at effectively protecting sea turtle populations.

sea turtle colonies may be destroyed by subsistence use alone.

There is urgent need for sea turtle sanctuaries throughout the islands and coastal waters of the Caribbean. Up to 20 years ago, the few existing marine parks were on islands or shoreline areas—usually where seabirds nested. As diving gear improved during the 1950's, growing numbers of people were introduced to the aesthetic and scientific marvels of the submarine environment, particularly the biological splendor of coral reefs. The concept of the submarine park rapidly took hold. Established in 1961, Buck Island National Monument in the U.S. Virgin Islands was the first Caribbean reef system to be specially designated as an undersea preserve. Its beaches are good turtle-nesting grounds, and the spectacular reefs are foraging habitat for hawksbills and young green turtles. Earlier, more extensive systems of reefs and sea-grass flats had been preserved in the Virgin Islands National Park on St. John. Since these two sanctuaries were created, marine parks have sprung up around many of the Caribbean islands, and proposals for several more are being considered.

For marine turtle conservation, the most important preserve in the Caribbean is Costa Rica's Tortuguero National Park. The area includes 18,947 hectares (46,932 acres) of tropical wet forest and palm swamp, and an 18-mile stretch of nesting beach for the largest breeding assemblage of green turtles in the Americas.

When Tortuguero was declared a national park, it seemed likely that it would long remain a "paper park." Because of its isolation, the refuge was little visited by either tourists or Costa Ricans, and protection of its forests and wildlife was difficult to ensure. Funds have not been sufficient to allow consistent management of all the 14 parks now in the Costa Rican system, and those refuges most likely to bring public support for the system have naturally received the greatest attention. But Tortuguero has not been neglected, and The Nature Conservancy has provided significant support in expanding and protecting the area. The Conservancy continues to assist Costa Rica's National Parks Foundation in creating, extending, and maintaining other national parks in the country. (See the July/August 1982 *News*).

At Tortuguero, the Park Service has assumed the unenviable job of enforcing the turtle laws. With financial help from outside sources, it has done this fairly effectively on the nesting shore itself. Offshore, however, poaching by harpooners who come up from Limon, 50 miles to the south, continues. By law the harpooners are forbidden to navigate within three miles of the nesting beach, but they pay the restriction little heed and regularly canoe in to spear the female turtles and mating pairs almost inside the breaker zone. Little can be done to stop this poaching because no craft suitable for longshore patrolling is available to the Park Service, and the Tortuguero surf is usually too strong to allow small boats to be launched from the beach.

Nonetheless, since the shore was declared a national park, exploitation at the Tortuguero turtle breeding ground has diminished. Moreover, three Nicaraguan packing houses that used to export

around 10,000 green turtles a year have been closed, thereby lowering pressure on the West Caribbean colony at its main feeding ground. In 1980, Costa Rica signed the Convention on International Trade in Endangered Species (CITES), and the legal export of turtle meat stopped. Today, the survival outlook for the green turtle colony that nests in Costa Rica and feeds on the Miskito Cays turtle-grass pastures of Nicaragua is much improved. However, the future of the other group of green turtle migrants, those that travel north from Panama, Colombia, and more distant places, is altogether unpredictable.

Because of their long-range migrations, a really effective campaign to protect the various species of sea turtles requires international cooperation—not only restriction of international commerce, but also collaboration in creating preserves or sets of preserves. No such international system of sanctuaries now exists. Four areas have been considered, however, as ideal sites to include in such a system. One of these, in the Sulu Sea between Sabah and the Philippine Islands, encompasses important feeding and breeding grounds of the Pacific green turtle. Here, a single extensive marine preserve is required, embracing both the Sabah nesting islands and the Philippine pasture flats. Such a sanctuary would help safeguard the entire range of an adult sea turtle population. Both the Sabah and the Philippine governments have favorably considered such an arrangement, but firm agreements have not yet been reached.

The other prospects for cooperative sea turtle preserves pose more complications, because in each case the sites would not be contiguous but widely separated. One of these is a pair of sanctuaries to protect the mature stages of the green turtle population that nests on Ascension Island and resides a thousand miles away on the coast of Brazil. Another such system, vital to the survival of the olive ridley (*Lepidochelys olivacea*) in the East Pacific, would be a trio of sanctuaries: one each in Mexico and Costa Rica, which contain the most important remaining nesting places; and another in Ecuador, where developing stages of both the Mexican and the Costa Rican ridley populations migrate to rich feeding grounds along the coast.

Creation of a reserve in Nicaragua's Miskito Cays to protect the feeding grounds of the West Caribbean green turtle population has long been a dream of conservationists attempting to save this species in the Caribbean. More recently, a sanctuary in Bocas del Toro Province of Panama has been proposed. The refuges in both Nicaragua and Panama would safeguard the population on its extensive feeding pastures, in developmental habitats, and along its migratory routes. Results of the West Atlantic Sea Turtle Survey of the National Marine Fisheries Service, and field studies by Anne Meylan, a sea turtle biologist at the University of Florida, indicate that the Bocas del Toro area is the richest territory in the entire Caribbean for sea turtles. The island of Bastimentos and nearby Zapatilla Cays also are under consideration by the Panamanian government as a national park. Their preservation not only would benefit the Tortuguero green turtle colony, but also would improve survival chances for the beleaguered hawksbill turtle and other marine wildlife.

IN A TRIPARTITE CONVENTION held in 1969, Costa Rica, Nicaragua, and Panama agreed to collaborate in the custody of their shared green turtle population. Today the Costa Rican nesting shore is a national park. At the World Conference on Sea Turtle Conservation in 1979, Reynaldo Arostegui of the Nicaraguan Institute of Natural Resources and the Environment announced that his government was interested in developing a national reserve in the Miskito Cays and adjacent coastal region of Nicaragua. In 1980, a group from the United States joined with Nicaraguan representatives in aerial and sea-surface surveys of the proposed reserve area. Since then, because of unrest in the Miskitia, the project has gone no farther, but it is still definitely alive. As recently as July, 1983, Sr. Jaime Incer, national representative of Nicaragua to the West Atlantic Sea Turtle Symposium in San Jose, Costa Rica, reaffirmed his government's continued interest in the project. The question now is whether Panama will save her share of the West Caribbean turtle colony, along with the biologically rich and aesthetically magnificent marine landscapes of Bocas del Toro Province, which are gravely threatened by disruptive development.

Throughout the diminished ranges of the world's sea turtle populations, the migratory habits of the species impose the same conservation problems. A colony that is safe in one habitat travels to other sites that are not protected. As with whales and migratory waterfowl, effective custodianship of the sea turtles of the world must involve the collaboration of two or more countries. Such agreements are hard to reach, but without them there is little hope that sea turtles will remain in the seas.

Dr. Archie Carr is graduate research professor at the University of Florida, chairman of IUCN's Sea Turtle Specialist Group, and technical director of the Caribbean Conservation Corporation, which has operated the turtle research station at Tortuguero for the past 26 years. His books, *Windward Road* and *So Excellent a Fishe,* are popularized accounts of his work with Caribbean sea turtles.

The Eastern Seaboard:

Avian Highway

by Roger F. Pasquier

FEW REGIONS ON EARTH see such heavy annual traffic in migrating birds as America's Eastern Seaboard, and no other region hosts quite as colorful and diverse an assemblage of intercontinental travelers. At least four separate elements participate in these migrations: songbirds, including many of tropical origin that leave their homes in the Caribbean and Central and South America to nest in U.S. and Canadian forests; sandpipers and plovers, which breed on the Arctic tundra and winter on the pampas and coasts of South America; ducks, geese, and swans from the Arctic and the prairies forced annually to coastal estuaries where water remains open; and hawks, eagles, and falcons that use the beaches and interior ridges as a north-south highway.

With birds flying on a variety of schedules, the migration season runs for much of the year. In February, waterfowl are beginning to head northwest to reach the prairie potholes when these thaw, while the traditional harbingers of spring, robins and bluebirds, are also covering the first legs of their spring flights. March and April see increasing numbers and varieties of birds moving north, but the apogee is in May, when the long-distance travelers from the tropics saturate the woods and marshes in their rush north to breed. Stragglers may be found into early June, and just four weeks later the first southbound sandpipers are on New England beaches, en route to Argentina.

"Fall" migration builds up through what to us is the height of summer, peaking with the tropical wintering birds in September. All autumn long, hawks and eagles glide south on currents caused by warm air bouncing off mountain ridges; while into November and December, flocks of waterfowl grow on the coastal wetlands.

The birds are not flying south each fall simply to escape the cold of an approaching winter; they are moving to areas where they will be able to find food during a season when it is not available in their breeding places. Many birds must, in fact, change their diets during winter migration. Insect eaters often depend on fruit and seeds to sustain them. For a few species, it is more efficient to fast while migrating than to lose time hunting. Broad-winged hawks, for example, fly from the Northeast to South America in large flocks. As the flocks converge in the narrow bottleneck of Central America, the birds number in the hundreds of thousands. There is not enough space for so many hawks to compete for their usual diet of frogs, snakes, and insects, so they save energy by fasting until they disperse over the forests of Colombia and Brazil.

Food is also a critical issue for shorebirds stopping on Atlantic beaches. Adult birds leave the Arctic long before food is depleted there—and often before their young are fully grown—because they are in a rush to reach the good beaches and mud flats on U.S. coasts. Studies have shown that the amount of food available in these areas declines over the summer, owing in part to the avian predations. Since the shorebirds must feed voraciously before embarking on the long overwater flight to South America, it is a real advantage for a bird to arrive early. This is further demonstrated by the many transient shorebirds that defend feeding territories at each of their stopover points.

In essence, then, migration is a series of flights with refueling stops on the way, and its success depends on the quality of these stations for resting and feeding. The routes used by each species re-

Gary Zahm

Pintail ducks in flight. Ducks, geese, and swans constitute one of four broad categories of migratory birds. The others are: songbirds; hawks, eagles, and falcons; plovers and sandpipers.

flect the bird's adaptation to the configurations of the land and water it must traverse. The migrations of the East Coast reached their present form thousands of years ago, when the last glacial period ended, raising water levels on the coast, creating barrier islands, and leaving terminal moraines such as Long Island, Block Island, and Cape Cod. Today, these seaboard areas are among the most important for avian migrants of many kinds. Although birds move north and south over a broad front, the special ecological and topographical features of the shorelines force many species to concentrate at a few favorable localities. This has important consequences for conservation, since these sites also attract developers and vacationers.

THE NATURE CONSERVANCY has long been active in protecting ecosystems essential to migrating birds. Many of the significant properties it has secured are now key elements in the National Wildlife Refuge System. A look at a few of those belonging to the Conservancy itself reveals the different needs of the East Coast's migrant birds.

The Arthur W. Butler Memorial Sanctuary in Westchester County just north of New York City, for example, typifies the woodlands songbirds require on their way north from the tropics. These birds fly at night, when they are less vulnerable to predators, and feed and rest during the day. They sometimes spend two or three days in one location

before resuming their flights. Their schedule has evolved so that they move north only after leaves emerge on the trees and insects hatch to feed on the leaves—insects that, in turn, serve as food for the birds. Migrating songbirds are not territorial. However, there is some ecological separation among them: certain birds typically forage on the ground, others in undergrowth, still others in the treetops. Competition in the trees is further reduced since some species search for food at the tips of outer twigs, while others scour the trunk or main branches.

Warblers, flycatchers, tanagers, orioles, and thrushes reach Butler Sanctuary in early May. Then, and again in September when birds are heading south, it is possible to see 100 species without difficulty—a greater variety of birds than will coexist in the habitat where each species nests. The sanctuary is also an excellent observatory for the fall migration of birds of prey. Fourteen species, including peregrine falcons and bald and golden eagles, have been sighted flying over the preserve. Broad-winged hawks are always the most numerous: 11,139 were counted in 1981. The daily and annual tallies collected here are compared with those from other hawk lookouts to determine migration routes and population changes.

Bruce Sorrie

A Cape May warbler rests en route to wintering grounds in the Caribbean. Throngs of songbirds migrate each year through Conservancy preserves on the Eastern Seaboard—Dickens Farm on Block Island, Butler Sanctuary in New York, and Cape May Meadows, New Jersey, among them.

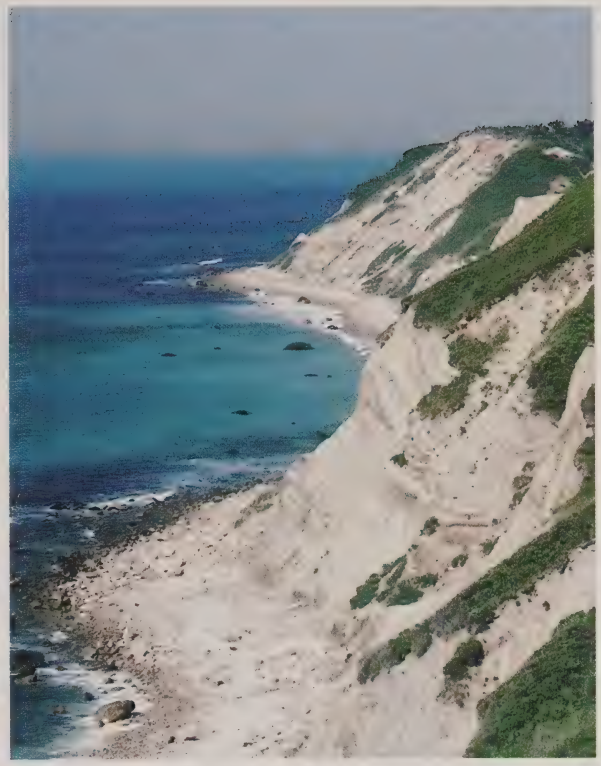
IN FALL, when migrating species on the East Coast are given an additional push south by the prevailing northwesterly winds, many smaller birds (especially the night migrants) are often blown off course and out to sea. At first light, the birds reorient and fly to the nearest land, even if this necessitates traveling north. In September and October, all the islands off the New England shoreline serve as magnets for these windblown birds. None is as famous, or attracts as many birdwatchers, as Rhode Island's Block Island, ten miles off the coast. Here the Conservancy is expanding its holdings at Dickens Farm, a haven for nesting birds. More than 275 bird species have been sighted on the steeply bluffed isle, including rare grasshopper sparrows and two species endangered in the state—upland sandpipers and northern harriers (or marsh hawks). The island's rolling meadows, shrubby thickets, and sparse woods are essential to myriads of exhausted migrants that would otherwise have nowhere to rest and feed before resuming their flight.

The congregations of migrating birds at Cape May, New Jersey, are even more spectacular. Pointing south between Delaware Bay and the Atlantic, the Cape is a funnel for birds flying down the coast. Eighteen miles of open water and violent winds lie between its tip and the next land. Since most small land birds prefer to avoid long flights over water, they are stalled here until weather conditions are favorable enough to permit a crossing, or the birds decide to fly northwest around the bay. The tip of Cape May is also an excellent place to see large numbers of falcons, including the peregrine, that follow the outer beaches on their way south, preying on the smaller birds concentrated there. With such tremendous densities of birds in a small area, it is essential that every bit of natural habitat remaining on Cape May be protected. The Conservancy's South Cape May Meadows, 180 acres donated by Combustion Engineering, Inc., in 1981, is part of a projected larger assemblage.

Block Island and Cape May are especially critical for birds that, in principle, should be avoiding the coastline entirely, owing to the dangers of its seaward winds and hungry falcons. In fact, research on migrants caught and examined by ornithologists at both these sites reveals that most songbirds traveling this route are young, and therefore inexperienced; complementary studies inland disclose a higher proportion of adult birds, indicating that migrants making the southward trip a second time choose a safer route.

The marshes, beaches, and mud flats of the Atlantic coast also attract a different set of migrants—not those that with experience travel in-

Guy Bonnivier



Nancy Adams

Conservancy projects protect prime portions of steeply bluffed Block Island (right)—a welcome stop-over point for wind-buffeted migrants each fall and a haven for nesting birds. The northern harrier or marsh hawk (above) has made this its only Rhode Island nesting site, and more than 275 other bird species have been sighted in the island's meadows, thickets, and woodlands.

land but species adapted to a semiaquatic life. On the tidal flats of the Conservancy's Virginia Coast Reserve, for example, more than 30 species of sandpipers, plovers, oystercatchers, and avocets partition the environment according to their needs. Some prefer sandy areas, others mud; some pick food off the sand or mud, others probe to varying depths or find prey in the water. These birds abound from March to late May and again from July through October. The waterfowl for which the Chesapeake Bay is most famous are present as well, both as migrants and winter residents.

Ecological partitioning among the 29 recorded species of swans, geese, and ducks also is clearly visible: scaup, scoters, and mergansers dwell on the ocean; bufflehead and goldeneye remain in the deep water of the estuaries where they dive for food; dabbling ducks like mallards and pintails tip up in the shallows to reach plants at the bottom; three species of geese and the whistling swan (now the tundra swan), each with a different length neck and different dietary preferences, search for food in deeper waters. In early spring, migrating ducks also arrive to court and pair off. Their nesting season in the Arctic is so short that they save time by finding a mate on the way north.

About half of America's wetlands have been altered beyond restoration. What remains—such as the beaches and marshes of The Nature Conservancy's Virginia Coast Reserve—is all the more valuable to shorebirds and waterfowl. Until recently, it was thought that migrating shorebirds moved down the coast rather casually, stopping first at one beach, then going on to the next. Research on marked birds has revealed, however, that individuals are often intensely loyal to certain sites, defending them against other migrants and returning to them year after year. When beaches are blanketed by sunbathers or mud flats are filled in, the birds have no place to go since other shorebirds have claimed their own territories. Similarly, waterfowl populations are known to have traditional preferences for certain stopover sites.

Even though individual birds may remain at a particular locale for only a day or two, the urgency of their need for food, rest, and shelter during their migrations is not diminished. In spring or fall most birds found at any East Coast site are transients. Unless the habitats these species require while en route are protected, the birds will be unable to complete their essential yearly journeys, north and south, to breeding and winter homes.

Roger F. Pasquier is executive assistant to the president of the International Council for Bird Preservation. The author of *Watching Birds: An Introduction to Ornithology,* Mr. Pasquier recently completed a book for the Smithsonian Institution on the birds of Panama.

Migratory Monarchs: An Endangered Phenomenon

by Robert Michael Pyle

IN THE SIERRA CHINQUA of Mexico's Transvolcanic Range, a group of conservationists gathered on a warm January day. Talks and television shooting were in progress. A lull in the activity gave me a chance to sneak away for a solitary look at the object of all the attention. Reclining against a boulder, I soaked up the winter sunshine, surrounded by millions of monarch butterflies: the big, black-veined orange butterflies that grace the milkweed meadows of North America, taste terrible to birds, and migrate north and south every year.

Although it is the one butterfly with which most people believe they are familiar, monarchs in fact are often confused with viceroys (their unrelated mimics), with tiger swallowtails, and even with some fritillaries. And, though it is common knowledge that monarchs migrate, many people are unaware of where they go. But the greatest mystery is how the insects manage to find and reach their migratory destinations year after year.

I thought about this as the first of the swirling monarchs alighted on my legs, then on my head and shoulders. Soon I had become a butterfly basking post. I regarded the insects perched on my knees. The orange was deep and rich, the black velvet deeper yet. On the whole the wings were near-perfect after thousands of miles of floating down the thermals. Fine scratches showed among the deeply piled scales—perhaps made by another butterfly's tarsus, a brushed branch, or a night spent in an evergreen.

Mountains ranged in several shades of gray-blue beyond the valley below, where a river of monarchs flows up in autumn and down again in spring. Now the streams had coalesced into a common body of butterflies that clustered in cool weather, papering the trunks of firs and forming great bags on the boughs. All around me, every shade of orange appeared, depending on back- or fore-lighting, upper- or underside profile, one wing thickness or two, angle and age. Hues ranged from orange-peel to salmon, from deepest pumpkin to palest peach.

The monarch's black veins and white spots stand out to warn potential predators of its milkweed-acquired unpalatability. The spots paint the palpi and face of each butterfly, giving it the appearance of having brows all around its great black eyes. At the proper slant to the sun, a mauve and green iridescence shimmers across the wings, especially at the tips of the forewings.

With wings outstretched, the monarchs basked on bushes and stones. They filled the air around me as well, volplaning nearly to the ground then striking again toward the sky. Their flapping was a soft, ever-present whirr in the afternoon air.

The sun dropped. In the forest, clusters of butterflies reformed. The sound of their wings grew louder within the walls of the woods. A monarch on a dead leaf vibrated to raise its muscle temperature, then took off to gain the safety of a bundle of butterflies. Others struggled to get away in the last sunbeams striking the forest floor; or, losing hold of one another in the firs' needles, fell into the shadows with soft thuds. High in the trees, the warm fox-fur color of the clusters changed to a cool pinkish gray as the roosting insects, clinging to every bit of bark and bough, closed their wings. Those remaining on the ground might well be frosted by morning. Indeed, the area's not infrequent heavy snows could send millions of roosting monarchs to the forest floor where they would freeze.

WHY DO THESE fragile creatures fly great distances southward out of North America to face the rigors of a high-country winter in Mexico? It is surprising enough that golden plovers and Arctic terns migrate vast distances and back; that sea turtles ply the ocean currents from one coast to another; or that salmon and eels return to their own breeding streams after years at sea. Yet all these creatures are relatively complex organisms. If vertebrate migration may properly be called miraculous, what are we to make of insect migration?

Many species of butterflies emigrate, in the sense that they conduct mass movements related to food supply, parasites, and other cyclical influences. Only a very few species show any evidence of a return flight. But the monarchs of North America are the only butterflies that conduct a regular mass migration in which virtually all individuals in the population take part. No other insects migrate so predictably, with specific destinations, in such a bird-like, back-and-forth manner—or in such numbers. Monarch migration is one of the world's great natural events, comparable to the immense mammal movements on Africa's Serengeti Plain.

The butterflies of the subfamily Danaiinae, to which the monarch belongs, are chiefly tropical in nature. They have not evolved the ability to overwinter in the North in any stage. But temperate America offers a rich source of the larval monarch's favored food—milkweeds. Professor Lincoln Brower, a zoologist at the University of Florida, has suggested that the monarchs have developed their migratory strategy—summering in the North with the milkweeds and wintering elsewhere—to exploit this resource.

There are two major components of the North American monarch population, each with its own set of migratory destinations. Those that winter in California on the Monterey Peninsula are a well-known feature and a great tourist attraction. Clusters occur from north of San Francisco south at least to the Mexican border. These groups are far less well known and have never been properly surveyed, so we don't know their population numbers. Nor have we determined the precise summering areas from which the butterflies travel to the California sites. Perhaps the Rocky Mountain chain separates the eastern populations that winter in Mexico from the western populations that return each year to the California coast, but further study is needed. A few large stands of Monterey cypresses and Monterey pines once served as the chief roost trees. Most of these stands have been altered by development and abandoned by the butterflies, however. The California monarch phenomenon might have been nearly lost but for introduced eucalyptus groves, to which the butterflies adapted.

The monarch is not restricted to North America. It occurs in Hawaii and over much of the world as an exotic; in Australia, it has even begun to display migratory tendencies. But the greatest populations are the native, migratory monarchs of North America.

Although overwintering monarchs have been known in California for a century, it was established only in 1975 that the monarchs of the eastern two-thirds or more of the continent fly south to winter in Mexico. After decades of searching, University of Toronto Professor Fred Urquhart and his associates discovered the Mexican overwintering grounds through Urquhart's 40-year-old monarch tagging program.

THE MEXICAN MIGRATIONS start in a northern meadow, when a new monarch emerges from its gilded jade chrysalis in late summer or early autumn. That individual begins to fly south, joining others along the way as the butterflies form impressive bivouacs in such places as Point Pelee, Ontario, Cape May, New Jersey, or along the Southeastern and Gulf coasts. They cross the Gulf of Mexico or the northern Mexican deserts, concentrating their numbers all the time. They soar on winds to save their wings and pause for nectar to build up their energy reserves. In November they reach certain small, remote mountain valleys west of Mexico City. Here these many millions spend the winter in vast aggregations, flying out by day for moisture, nectar, and solar warmth, returning to their huge communal roosts for the night and during threatening weather.

The spring equinox triggers mating, followed by the monarchs' return North. Egg-laying takes place en route. Most of the original migrants die on the return journey—very few complete the entire round trip. The offspring (second, third, or fourth generations) of the original voyageurs regain the northern outposts all across America and well into Canada east of that ill-defined line that separates the West Coast migrants from the Mexican. A series of spring and summer generations leads to the fat-storing, non-reproductive individuals that will fly southward again in the fall.

The behavior of California migrants is much the same, but they overwinter in cool, foggy coastal areas rather than high mountains. Why, since most migrating birds journey to warmer regions, do almost all the monarchs travel to chilly climates? The answer is straightforward: monarchs cannot overwinter in hot desert or tropical areas, where constant activity would burn the fat needed for their return trip, and competition for nectar with

Frans Lanting

Roosting monarchs cling to the bark of a eucalyptus tree on California's Monterey Peninsula, a major wintering spot for the species.

resident insects would be intense. Instead, the butterflies require sites where cool days will limit their expenditures of energy and where nighttime lows seldom dip below freezing. Only the misty seaside groves of California and a few high valleys in mid-Mexico seem to furnish the correct conditions. How the insects find these perfect places is still unknown, although instinct, magnetism, winds, and solar navigation may all be involved. Since it is the progeny of the original migrants who return from the wintering habitats, no learning is involved; rather, their navigation is solely by instinct, and it is a wonder that the phenomenon occurs at all.

Whether or not monarch migrations will continue is another open question. In California, the

high value of coastal lands and the increasing desire to exploit the areas the butterflies use have led to many lost colonies. Pacific Grove, so-called "Butterfly Town, U.S.A.," has unwittingly sacrificed several of its major butterfly groves to expand facilities for residents and visitors—clearly a case of "killing the golden geese." Moreover, since a survey of sites has not been completed, monarch habitats are destroyed as much out of human ignorance as greed. In Mexico, the conflict lies in local economics: the great need for local village income dictates the logging of fir trees literally out from under the butterflies. Even selective logging opens the forest canopy. Monarch researcher Drs. Lincoln Brower and William Calvert have found that this allows the ambient nighttime temperature in the forest to drop below freezing, killing the butterflies. Fire and tourist disturbance are additional risks.

In 1976, the Lepidoptera Specialist Group of the International Union for Conservation of Nature and Natural Resources (IUCN) declared the overwintering monarchs to be their highest priority in world butterfly conservation. This decision was further clarified and expanded in 1983 with the publication of IUCN's first *Invertebrate Red Data Book*. The monarch is not an endangered species. Nonetheless, the species is highly vulnerable because the butterflies concentrate in great numbers at only two major wintering sites. Should these habitats be destroyed, we could lose the bulk of North America's native monarch populations. These winter roosting sites represent the grandest insect spectacle on Earth and support one of the most scientifically challenging migratory processes in the animal kingdom. For these reasons, IUCN and the World Wildlife Fund created a new category for the monarch: Endangered Phenomenon.

Frans Lanting

Dew-spangled monarch.

Preservation efforts for the monarch have only begun. In Mexico, the government and the State of Michoacan are committed to safeguarding that country's contingent. They are working cooperatively with international agencies and organizations, such as the World Wildlife Fund, to establish a series of reserves for research and protection, as well as carefully managed areas where tourist income will be sought to replace lost logging revenues. But their endeavors need support.

In California, monarch authority John Lane considers the most immediate objective to be a thorough survey of all overwintering sites and an assessment of their status. The California Natural Diversity Data Base (a state heritage program undertaken by The Nature Conservancy and the California Department of Fish and Game) is gathering information on the monarch to assess the need for protection. Three to four colonies have been discovered at the Conservancy's Santa Cruz Island, the largest and biologically richest of the Channel Islands, which lie off the coast from Santa Barbara. These monarch colonies are unique in being residents—not only wintering in clusters on the island but summering there as well, because of the abundant milkweed.

THE OVERWINTERING MONARCHS of Mexico roost on a fir called *Oyamel*. Its scientific name, *Abies religiosa*, refers to the sacred role it played for the Aztecs, who burned its fragrant wood during their ceremonies. Now the tree is sacred for another reason. Although the devaluation of the peso and Mexico's other economic problems make it difficult for officials to observe the sanctity of the monarch groves, they intend to do so if at all possible. Americans and Canadians must be equally devoted to meeting the monarch's habitat needs in North America. If we succeed, we will retain not only the species but a natural world phenomenon that cannot be devalued.

Robert Michael Pyle served from 1976 to 1983 as chairman of the IUCN Lepidoptera Specialist Group. He is founder of the Xerces Society, author of the *Audubon Society Field Guide to North American Butterflies*, and presently a full-time writer in Gray's River, Washington.

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ECOLOGY FORUM

No. 50
by Robert Chipley
Director, Preserve Selection and Design

PRESERVE DESIGN AND MIGRATORY SPECIES

Because The Nature Conservancy is working to protect habitat for the rarest and most endangered species—including those that are down to their last populations—we have a special obligation to see that any proposed preserve really will do the job. We have had to become experts at *designing* preserves to safeguard and perpetuate these natural elements. Many factors come into play in determining the appropriate size and configuration of a sanctuary—the biological requirements of the species it supports, the disposition of adjacent lands, drainage patterns, existing waste-disposal systems, and possible problems with pollution, to name a few.

For stationary or sedentary elements, such as plants and many animals, the process is relatively straightforward. Once a site has been selected, by virtue of its documented habitat values, Conservancy scientists begin an extensive review of all source materials on the biology of the target species. Comprehensive information is generally available from one of the natural heritage programs (Conservancy-designed inventories of ecologically significant elements and their occurrences) now covering two-thirds of the country. A thorough familiarity with existing knowledge on the species is essential to estimating its numbers at the site, judging the condition of the occurrence, assessing its viability and defensibility, and anticipating stewardship problems.

The next step is to review all available materials on the site itself: occurrence records from the heritage program, field surveys, topographic maps, aerial photographs, and so on. Finally, the preserve designer visits the site itself and then ascertains from specialists like soil scientists and engineers just how the system and its workings may affect the health and welfare of the significant species. On the basis of the review and survey work, the Conservancy will plot onto an enlarged section of a topographic map the boundaries the preserve must have in order to sustain the occurrence, as well as the boundaries of a minimum surrounding buffer area (often necessary for management purposes or for keeping encroaching development at bay). Land ownership is then researched and the tract boundaries drawn in on the same map or an overlay. Once the tracts are ranked as to their importance to the element for which the preserve is being created, the Conservancy sets to work protecting the land.

This preparation, though it adds to the costs of the project, is both necessary and economical in the long run. By way of illustration, a Conservancy preserve established some time ago to protect a highly endangered plant (two-thirds of its world population is found at the site) is now threatened by plans to develop a ridge above it. If such alterations occur, the resulting change in drainage patterns may well damage the sensitive plant at this key location. Had we anticipated the problem and included the ridge within the boundaries, we would have spared ourselves time and money—and spared the plant this threat. Now that we understand better what the "adequate" boundaries of the preserve should be, we are working to establish them.

Not surprisingly, choosing and designing preserves to support migratory species can be more complicated. Many sites host migrants only briefly, their primary significance arising from the fact that they lie somewhere between points A and B and are suitable for some temporary need. Many of the Conservancy's preserves fall into this category (we have long lists to demonstrate it), but so do city parks and suburban backyards. Though these areas are undeniably useful to the migrants, the destruction of any one of them would not substantially reduce the numbers of a particular species. If we really intend to help migratory animals, we have to focus on the bottlenecks in their life

histories—that is, those places where they are most concentrated and/or most vulnerable to disturbance. These include not only breeding grounds but also regular stopover or "staging" areas and important overwintering sites.

Some bottlenecks are strictly geographic: places like Cape May in New Jersey, Long Point in Ontario, and Block Island, Rhode Island (all of which are sites of Conservancy projects) are the last touch-down points for birds before long journeys over water. The migrants gather at these locations to wait out unfavorable winds and weather. Even more critical are areas offering a resource on which the migrants utterly depend. And when the migrant is an endangered species, disruption at even one of these sites can spell disaster for a significant portion of its entire population. The Conservancy has been working assiduously to select and design preserves at such pressure points.

One interesting case is the Crystal River Manatee Sanctuary. Manatees on Florida's Gulf Coast spend summers near the mouth of the Suwannee River (the Conservancy has protected prime acreage here). But when coastal water temperatures begin to drop, these federally endangered marine mammals migrate some 50 miles to the south, where up to 120 of them—more than ten percent of the U.S. population—congregate around warm springs in Crystal River's King's Bay. By purchasing 14 islands, privately owned submerged lands, and an upland buffer zone (which, if developed, might have threatened the preserve), the Conservancy secured the wintering site last year. Though only 54 acres in area, the preserve protects one of just six natural warm-water refuges for the species.

A current Conservancy project at Hubbard's Cave, Tennessee, accommodates another federally endangered species at a critical point in its life cycle. Gray bats—which migrate, often in large groups, from summer caves to cooler winter caves —are more vulnerable in the latter, where they are most concentrated. Disturbance during hibernation depletes the bats' energy reserves, which can be fatal. Nine major hibernacula (including Hubbard's Cave, on which the Conservancy holds an option) support 95 percent of the entire gray bat population. In designing its projected preserve here, the Conservancy has included within the boundaries not only the main entrance to the cave but also land overlying the hibernaculum site and property with streams that drain into the cave. These boundaries, in addition to controlled access to the cave and the closing off of the critical section, should protect the wintering bats.

We are continuing to select and design preserves for the piping plover as well. Once relatively common in its breeding grounds on the Atlantic Coast, Great Lakes, and Great Plains, the bird is now a rarity—with no more than 3,000 breeding pairs. The major decline in the species has occurred along the Atlantic Coast and Great Lakes, where beach development has driven it from its breeding grounds. No project in these areas of the country could protect more than a few dozen pairs. But certain shallow alkali lakes in the Great Plains, too salty and too muddy to invite recreation, continue to suit the birds' needs perfectly. The waters teem with invertebrate prey, and the white, pebbly shorelines provide camouflage for the plovers and their eggs. While diminishing elsewhere, the birds actually seem to be flourishing at this last real stronghold. In fact, at least half of the remaining pairs breed here. A few carefully designed, defensible Conservancy preserves embracing the lakes and their margins could ensure breeding habitat for up to 25 percent of the plover's world population.

These protection efforts are heartening. It is plain, however, that in the long run we cannot guarantee that a preserve at any one site (however sensible its design) will be a successful biological reserve for a particular migratory species. If an animal's wintering grounds outside the United States are destroyed, then our protection of its breeding grounds isn't going to help it much. Even with a stationary element, gaps in our knowledge of its needs (very few elements have been exhaustively studied) can result in our leaving something out. For example, a rare plant's welfare may depend on a factor outside the preserve—say, an insect pollinator. Should critical habitat for that insect be destroyed elsewhere, the rare plant may be jeopardized with little warning. For many preserves, adjacent lands are important in the functioning of the ecosystem, but as burgeoning development "islands" a preserve, that system can deteriorate in unexpected ways.

What we do, really, by designing preserves to accommodate migrants at critical junctures in their passages is to tip the scales in favor of their survival. Surely this is worth the small fraction of our resources its costs us.

NEXT IN THE NEWS:
SAVING WILD SPECIES

The November/December issue explores the promise wild species hold for agricultural, medical, and industrial improvements. By saving plants and animals—from disease-resistant, perennial corn plants to sea snakes that yield an anti-coagulant—we may save ourselves.

NEW PROJECTS

GEORGIA

Springhill Plantation/Titi Hammock (Thomas County). Just north of the Florida border, in a region where pines are the rule, a climax stand of beech-magnolia forest (*Fagus grandifolia-Magnolia grandiflora*) takes exception. The Conservancy's purchase of a conservation easement on 281 acres now protects a portion of the woods, one of the most extensive undisturbed examples of its community type in the entire Southeast. Springhill Plantation is a project of the Conservancy's far-reaching National Critical Areas Conservation Program.

ILLINOIS

Loda Prairie (Iroquois County). By means of a property-exchange transaction, the Conservancy has acquired a 3.5-acre mesic blacksoil prairie tract in eastern Illinois. (Thanks go to the Natural Land Institute for its assistance.) Dominated by Indian grass, big and little bluestem, and prairie dropseed, the community includes more than 130 species of native prairie plants, including the prairie white-fringed orchid (*Habenaria leucophaea*), listed as endangered in the state. The Illinois Field Office manages the land, which has been dedicated as a state nature preserve.

Weingart Road Sedge Meadow—Addition—(McHenry County). Assisting the McHenry County Conservation District, the Conservancy has purchased 18 acres of sedge meadow and marshland between the Fox River and Pistakee Lake in northern Illinois. The property extends the conservation district's existing 34-acre preserve, established with Conservancy help in 1981. Four plant species classified by the Illinois Natural Areas Inventory as "notable features" (by virtue of their rarity) occur here: bog willow, hoary willow, marsh cinquefoil, and small bedstraw.

INDIANA

James-Tippecanoe Wetland—Addition—(Kosciusko County). This stretch of shallow fresh marsh, deep fresh marsh, and shrub swamp is part of the most extensive wetland complex in northern Indiana. Linking Lake Tippecanoe and James Lake, it provides breeding, nesting, and feeding grounds for numerous waterfowl. Three plant species considered rare in Indiana (shinleaf, bog buckbean, and an uncommon bladderwort) occur here. Purchase of a 26-acre addition brings Conservancy-protected habitat to 219 acres. The preserve is managed by the Muncie YMCA as part of its Camp Crosley environmental program.

MAINE

Mistake Island (Washington County). The ecological significance of 30-acre Mistake, lodged in the Atlantic between Great Wass and Steele Harbor islands, belies its name. In addition to an exemplary coastal headland shrub community (restricted in the U.S. to this portion of Washington County), the island boasts four plant species of special interest. The rarest, star gentian, is known from only three sites in the state; bird's-eye primrose is known from seven; beachhead iris and roseroot stonecrop, while locally common, are regionally uncommon. The Conservancy has purchased 26 acres and will manage the remaining four under license to the landowner, the U.S. Coast Guard. This is one of eight projects included in the Maine Chapter's new $610,000 "Islands of Life" fund-raising campaign.

Sheep Island/North Haven—Addition—(Knox County). Apparently uninhabited for all time—except by songbirds, small mammals, and invertebrates—this 25-acre island off the northern tip of North Haven in East Penobscot Bay is a gift of Mr. and Mrs. Arnold Beveridge (who donated a conservation easement on the property to the Maine Chapter in 1974). In addition to a coastal-spruce forest typical of the region, the low-lying island bears a deciduous wood (predominately yellow birch and red oak) notable for the size and age of its trees.

MARYLAND

Nassawango Creek—Addition—(Worcester County). An untrammeled vestige of the towering cypress forests that greeted the first settlers, Nassawango Creek Preserve lies along a tributary of the blackwater Pocomoke River on Maryland's Eastern Shore. With the purchase of this 74-acre tract Conservancy protection spans 2,237 acres. Seventeen species of warblers, as well as wood ducks and pileated woodpeckers, thrive along the stream—as do numerous mammals, including river otters, minks, gray foxes, opossums, weasels, and flying squirrels. The Maryland-Delaware Field Office, which manages the preserve, plans a completed assemblage of 2,500 acres along 15 miles of Nassawango Creek.

MISSOURI

Marmaton River Bottoms (Vernon County). Two recently purchased tracts near western Missouri's Marmaton River encompass some of the state's finest wet prairie-land, a community of which fewer than 1,000 undisturbed acres remain. The new 210-acre preserve hosts marsh hawks, listed as endangered in the state, as well as great blue herons, grasshopper sparrows, and meadow mice. It will be managed by the Missouri Chapter with assistance from the Missouri Department of Conservation.

Niawathe Prairie—J. R. McNeill Addition—(Dade County). To avert development or agricultural conversion on a wildlife-rich upland prairie tract in southwestern Missouri, the Conservancy has purchased 80 acres for addition to the existing 240-acre dedicated state natural area. Niawathe is habitat for four species listed for protection in the state: marsh hawk, Mead's milkweed (both endangered), prairie chicken, and Henslow's sparrow (both rare). The Missouri Department of Conservation, which manages 160 adjacent acres as well as another Conservancy-owned parcel to the north, will lease the land. Missouri Chapter fund raisers are seeking $81,420 to cover project expenses.

NEW YORK

The Cook Preserve (Livingston County). A wet and hummocky calcareous fen meadow in the western Finger Lakes region harbors New York's largest known colony of rare small white lady's-slippers (*Cypripedium candidum*). The Conservancy has purchased a five-acre parcel to secure the safety of the orchid, whose range in the nation has contracted dramatically at the same time that its numbers have declined at many sites. The Western New York Chapter and the New York Field Office have set fund-raising sights at $19,700 for their outstanding new preserve.

Griffith Preserve—Addition—(Suffolk County). Another gift of land from Eleanor B. Griffith, this two-acre parcel expands the assemblage—primarily upland oak-hickory forest with a small stretch of South Shore tidal marsh. Established in 1975, this Long Island Chapter preserve has grown steadily in the intervening years and now embraces 17 acres.

Thousand Acre Swamp—Addition—(Monroe County). An Ice-Age remnant just seven miles east of Rochester, Thousand Acre Swamp supports some 50 wildlife species and more than 500 plant species from 80 families. Recent purchase of a 19-acre property, through which a principal feeder stream enters the swamp, extends the preserve southeastward, providing buffer for and critical access to adjacent Conservancy lands. The Western New York Chapter's Thousand Acre Swamp Committee manages the area—from cattail marsh and swamp to dry, stony upland forest. Acreage now stands at 236.

OHIO

Buzzardroost Rock—Addition—(Adams County). A shortgrass prairie plot tops Buzzardroost Rock, a promontory that rises from steep forested slopes over Ohio Brush Creek. Attempts to explain the existence of such prairie refugia in the Ohio woods gave rise in the 1920's to a theory of the "xerothermic period" (the peak of the millenia-long heat wave that melted the continental ice), when Midwestern grasslands reached eastward into Indiana and Ohio—only to recede in the slightly cooler era that followed. A recently acquired 36-acre parcel will be transferred to the Cincinnati Museum of Natural History for inclusion in its Edge of Appalachia Preserve System, to which the Ohio Chapter has devoted acquisition efforts for two decades. Conservancy-protected lands at Buzzardroost Rock now exceed 500 acres.

OREGON

Eight Dollar Mountain—Addition—(Josephine County). Here in the rain shadow of the Siskiyou Mountains, a Mediterranean-like climate and serpentine soils foster the growth of rare plants in the state's greatest concentration. *Hastingsia bracteosum, Senecio hesperius,* and *Epilobium oreganum* head the roster. Purchase of a four-acre tract protects an additional portion of the preserve's unusual bog and grassland communities. Total acreage now stands at 25, embracing bog, wet meadows, azalea thickets, chaparral, and Jeffrey pine forest. The Oregon Field Office manages the area in cooperation with the U.S. Bureau of Land Management, which oversees a 640-acre property to the west.

SOUTH CAROLINA

Cat Island (Georgetown County). To expand the state's 20,000-acre Tom Yawkey Wildlife Center (an hour's drive up the coast from Charleston), the Conservancy acquired 376 adjacent acres of upland woods, brackish and open salt-marsh. The addition provides feeding grounds for the island's wildlife, including nesting bald eagles, and habitat for American alligators—both of them federally protected species. Endangered peregrine falcons stop at the sanctuary on their migrations; wading birds and osprey are abundant. The land has been

Beth Yanuck-Platt *Corydalis aurea*

Limerick Cedars Pavement Barrens

The appellation may not capture the imagination, but the plant community it signifies is a singular attraction. "Calcareous pavement barrens" are distressingly rare—their remnants restricted to Michigan and the environs of Lake Ontario. The Conservancy's recent purchase of 196 acres in northwestern New York spells protection for a portion of the largest and least disturbed site in the nation.

As in the cedar glades and barrens of the South and Midwest, the trees at Limerick are stunted, the thin soils calcareous. But this community is seasonally inundated in spots: its nearly seamless limestone "pavement" (exposed bedrock) drains poorly, ponding up in the spring in lower areas. At these sites, which look like small fens, sedges and rushes abound.

Along with the cedars (northern white interspersed with eastern red) that grip the scanty soil here, prairie plants are characteristic. One theory casts the prairie species in these open meadows as relicts of the xerothermic period, when a warmer, drier climate allowed Midwestern grasslands to reach eastward. In the slightly cooler climate that has followed, such plants hold on only where local conditions conspire in their favor against encroaching woods.

Seven of the plant species at Limerick Cedars are listed in *Rare Plants of New York State*, a 1981 New York State Museum text. They include Craw's sedge, prairie dropseed, and golden corydalis.

The pavement barrens community at Limerick Cedars extends across 500 acres. Having brought nearly half under protection, the Central New York Chapter, which manages the new preserve under the direction of the New York Field Office, is working to raise $45,000 to match a National Critical Areas Conservation Program grant.

conveyed to the South Carolina Wildlife and Marine Resources Department for management.

VERMONT

Chickering Bog—Additions—(Washington County). One of the state's finest graminoid fens, Chickering has gotten high marks from the Vermont Natural Areas Inventory. Purchase of two adjacent 30-acre tracts, one of which the Conservancy has leased for management since 1982, safeguards a substantial portion of the bog's open mat (a float of sedges and grasses) and surrounding woods. *Carex livida* (livid sedge) occurs here at its only known Vermont site, *Utricularia minor* and *Scirpus subterminalis* at one of very few in the state. The Vermont Chapter manages the new preserve.

VOLUNTARY PROTECTION

As the *News* has frequently noted in recent years, the Conservancy advocates the protection of significant natural lands through alternatives to outright acquisition. Natural area registry programs—established by the Conservancy and cooperating agencies in a number of states—serve to notify landowners of outstanding ecological features on their properties. Through such programs, private, corporate, and public landholders have agreed to protect vital resources. The following areas were recently safeguarded in this fashion through the Conservancy's efforts.

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Callaboose Magnolia Site, 60 acres
Candlewood Farm, 5 acres
Craigmile Farms, 20 acres
Hancock's Cave, 10 acres
Hildebrand Lake, 15 acres
Mill Stream Tract, 5 acres
Trillium Woods, 37 acres

MARYLAND

Charlestown Wharf, .5 acre
Glen Cove Woods, 3 acres
King's Creek Marsh, 10 acres
The Marshes Rookery, 45 acres
Plum Creek Swamp, 190 acres
South Melville Crossroads Pothole, 12 acres

MINNESOTA

Fox's Plateau, 40 acres
Haaland Trout Lily Site, 20 acres
Hokah Prairie, 100 acres
Little Cannon River Woods, 10 acres
Lund Prairie, 50 acres
Miller Prairie, 375 acres
Schellberg Prairie, 180 acres

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As part of their charitable giving programs, many corporations have instituted matching gift programs for their employees. If you work for one of the companies listed below, your employer (or its foundation) can match your contribution to The Nature Conservancy. Your dollars will go twice as far to save critical natural habitat.

If your company has a matching gifts program and is not listed, why not see if the Conservancy qualifies under the terms of the program? Perhaps your membership dues or contributions to a particular project could be doubled by your company.

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